forming a semiconductor film formed over a substrate;

irradiating a laser light onto the semiconductor film to crystallize the semiconductor film; and

controlling an irradiation energy of the laser light based on a refractive index of the semiconductor film on which the laser light has been irradiated,

wherein the laser light is repeatedly irradiated onto the semiconductor film until the refractive index of the semiconductor film becomes within a predetermined range,

wherein the refractive index is measured by an ellipsometer.

7. The method according to claim 6, wherein the laser light is selected from the group consisting of KrF excimer laser light, ArF excimer laser light and XeCl excimer laser light.

8. The method according to claim 6, wherein the irradiating step is performed by relatively scanning the laser light with respect to the substrate.

9. A method for manufacturing a semiconductor device comprising the steps of:

forming a semiconductor film formed over a substrate;

irradiating a first laser light onto the semiconductor film to crystallize the semiconductor film; and

irradiating a second laser light onto the semiconductor film to further crystallize the semiconductor film,

wherein an irradiation energy of the second laser light is controlled so that a refractive index is within a predetermined range,

wherein the refractive index is measured by an ellipsometer.

10. The method according to claim 9, wherein each of the first and second laser lights is selected from the group consisting of KrF excimer laser light, ArF excimer laser light and XeCl excimer laser light.

11. The method according to claim 9, wherein the irradiating step using each of the first and second laser lights is performed by relatively scanning the laser light with respect to the substrate.

12. A method for manufacturing a semiconductor device comprising the steps of:

forming a semiconductor film formed over a substrate;

irradiating a first laser light onto the semiconductor film to crystallize the semiconductor film;

measuring a first refractive index of the semiconductor film on which the first laser light has been irradiated;

irradiating a second laser light onto the semiconductor film to further crystallize the semiconductor film; and

measuring a second refractive index of the semiconductor film on which the second laser light has been irradiated,

wherein an irradiation energy of the second laser light is controlled based on the first refractive index.

13. The method according to claim 12, wherein each of the first and second laser lights is selected from the group consisting of KrF excimer laser light, ArF excimer laser light and XeCl excimer laser light.

14. The method according to claim 12, wherein the irradiating step using each of the first and second laser lights is performed by relatively scanning the laser lights with respect to the substrate.

15. The method according to claim 12, wherein the first and second refractive index are measured by an ellipsometer.

16. A method for manufacturing a semiconductor device comprising the steps of:

forming a first semiconductor film over a first substrate;

irradiating a first laser light onto the first semiconductor film to crystallize the first semiconductor film;

measuring a refractive index of the first semiconductor film;

forming a second semiconductor film formed over a second substrate; and

irradiating a second laser light onto the second semiconductor film to crystallize the second semiconductor film,

wherein an irradiation energy of the second laser light is controlled based on the refractive index of the first semiconductor film so that the refractive index of the second semiconductor film is within a predetermined range.

17. The method according to claim 16, wherein each of the first and second laser lights is selected from the group consisting of KrF excimer laser light, ArF excimer laser light and XeCl excimer laser light.

18. The method according to claim 16, wherein the irradiating step using the first light is performed by relatively scanning the first laser light with respect to the first substrate.

19. The method according to claim 16, wherein the irradiating step using the second light is performed by relatively scanning the second laser light with respect to the second substrate.

20. The method according to claim 16, wherein the refractive index is measured by an ellipsometer.

* * * * *

density can be made approximately constant for respective substrates, to always provide the same annealing conditions.

[0092] Next, an interlayer insulating film **510** is formed on the substrate of **FIG. 5**(C) with an insulative material such as silicon oxide or a combination of silicon dioxide and silicon nitride. After formation of holes, a source electrode **511** and a drain electrode **512** are formed. A gate electrode (not shown) is formed at the same time. The substrate is then subjected to a heat treatment of 350° C. for one hour in a hydrogen atmosphere to neutralize dangling bonds in the active later. Thus, a thin-film transistor is completed.

[0093] With the constitution of this embodiment, thin-film transistors can be formed by using crystalline silicon films that are always in a state close to a particular state, and the laser light annealing (of the source and drain regions) can always be performed under conditions close to particular ones. Therefore, thin-film transistors having almost identical characteristics can be obtained.

Embodiment 3

[0094] This embodiment is directed to a technique of correcting the laser light illumination conditions on a real-time basis. The data of **FIG. 4** represent a relationship between refractive indices (as measured by the ellipsometry) of crystalline silicon films whose crystallinity has been improved by illumination with KrF excimer laser light and illumination energy densities (mJ/cm^2) of laser light used. As mentioned above, the illumination energy densities of **FIG. 4** do not represent actual energy densities of laser light used.

[0095] However, it is understood that the refractive index of a crystallinity-improved crystalline silicon film and the energy density of illumination laser light has a relative relationship that is proportional as shown in **FIG. 4**. Therefore, by constantly controlling the laser light illumination energy so as to provide a predetermined refractive index, a constant illumination energy density value can always be obtained.

[0096] Therefore, where it is necessary to perform illumination using laser light of a constant output, the illumination energy density of laser light can be calibrated when necessary by separately preparing a monitoring crystalline silicon film and causing the laser-light-irradiated crystalline silicon film to always have a constant refractive index.

[0097] For example, a consideration will be made of a case where it is necessary to irradiate laser light having predetermined energy to an illumination object body. In this case, a monitoring silicon film is separately prepared, and the refractive index of the silicon film crystallized or crystallinity-improved by the laser light illumination is measured for each necessary manufacturing step. The laser light illumination energy is so changed that the measured refractive index value becomes close to a predetermined value. As a result, a correction (calibration) can always be effected so as to make the laser light illumination energy closer to a particular value every time an operation using the monitoring silicon film substrate is performed. That is, the laser light illumination energy can be made to fall within a certain range.

[0098] The above constitution can be applied to various processing apparatuses using laser light, such as an annealing apparatus, a working apparatus and a cutting apparatus.

[0099] As described above, according to the invention, various processing effects caused by laser light illumination can be evaluated by measuring the refractive index of a thin film whose quality is changed by illumination with laser light. Further, by measuring the refractive index of a thin film whose quality is changed by illumination with laser light, the illumination energy value of laser light can be evaluated in a relative manner. This fact enables the laser light illumination energy to be controlled so as to become equal or close to a particular value.

[0100] By utilizing the present invention, a laser light annealing operation is allowed to always exhibit the same effects. Therefore, for example, it becomes possible to manufacture thin-film transistors having almost identical characteristics. It becomes possible to evaluate, easily and simultaneously, the crystallinity of a crystalline silicon film for thin-film transistors and its flatness.

[0101] The present invention can be applied to manufacture of various semiconductors and control of illumination energy or power of laser light.

What is claimed is:

1. An optical processing apparatus comprising:

means for irradiating a light to a semiconductor film; and

means for controlling an irradiation energy of the light based on a refractive index of the semiconductor film to which the light had been irradiated.

2. An optical processing apparatus comprising:

means for irradiating a light to a semiconductor film;

means for controlling an irradiation energy of the light based on a refractive index of the semiconductor film to which the light had been irradiated; and

means for causing the light to be repeatedly irradiated to the semiconductor film until the refractive index of the semiconductor film becomes a predetermined value.

3. A method for manufacturing a semiconductor device comprising the steps of:

forming a semiconductor film over a substrate;

irradiating a laser light onto the semiconductor film to crystallize the semiconductor film, and

controlling an irradiation energy of the laser light based on a refractive index of the semiconductor film on which the laser light has been irradiated so that the refractive index of the semiconductor film is within a predetermined range,

wherein the refractive index is measured by an ellipsometer.

4. The method according to claim 3, wherein the laser light is selected from the group consisting of KrF excimer laser light, ArF excimer laser light and XeCl excimer laser light.

5. The method according to claim 3, wherein the irradiating step is performed by relatively scanning the laser light with respect to the substrate.

6. A method for manufacturing a semiconductor device comprising the steps of: